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29. (new) The low temperature autoignition composition of claim 27, wherein the metal fuel is present in an amount at least sufficient to provide a substantially stoichiometric mixture of metal fuel and oxidizer.

REMARKS

Claims 1, 2, and 4 to 24, as amended, and new claims 25 to 29 appear in this application for the Examiner's review and consideration. Claim 3 has been canceled without prejudice to applicants' right to file one or more continuation or divisional applications to the subject matter of that claim. The new claims are directed to preferred embodiments of the invention. The new claims and the amendments are fully supported by the specification and the claims as originally filed. Therefore, there is no issue of new matter.

Election under 35 U.S.C. § 121 to a single ultimate, disclosed species for prosecution on the merits was required for the reasons set forth on pages 4 and 5 of the Office Action. In response, Applicants confirm the election of molybdenum as the fuel and a mixture of silver nitrate, potassium nitrate, and guanidine nitrate as the oxidizer. Claims 1 to 6 and 13 to 24 and new claims 27 to 30 are generic. New claim 25 reads on the elected species.

For the reasons set forth on pages 3 and 4 of the Office Action, the specification was objected to, and claims 1 and 13 to 18 were rejected under 35 U.S.C. § 112, first and second paragraphs, as allegedly not being described in such full, clear, concise, and exact terms as to enable one skilled in the art to make and use the invention, and/or for allegedly failing to particularly point out and distinctly claim the subject matter Applicants regard as the invention.

In response, Applicants submit that, for the reasons set forth below, the claims, as amended, are not indefinite, and are fully supported by the specification as originally filed, such that one of ordinary skill in the art would be able to make and use the claimed invention without undue experimentation.

With regard to the scope of the present claims, claim 1, as amended, recites a low temperature autoignition composition consisting essentially of an intimate mixture of (1) an oxidizer composition comprising silver nitrate or a comelt or mixture comprising silver nitrate and at least one additional component selected from the group consisting of an alkali metal nitrate, an alkaline earth metal nitrate, a complex salt nitrate, a dried, hydrated nitrate, an alkali metal chlorate, an alkali metal perchlorate, an alkaline earth metal chlorate, an

alkaline earth metal perchlorate, ammonium perchlorate, sodium nitrite, potassium nitrite, silver nitrite, a complex salt nitrite, a solid organic nitrate, a solid organic nitrite, and a solid organic amine, where the oxidizer composition has at least one of a crystalline phase transition, a melting point, a eutectic point, or peritectic point at a temperature of no more than about 250°C, and (2) a powdered metal fuel, selected from the group consisting of molybdenum, calcium, strontium, barium, titanium, zirconium, vanadium, niobium, tantalum, chromium, tungsten, manganese, iron, cobalt, nickel, copper, zinc, cadmium, tin, antimony, bismuth, aluminum, silicon, and mixtures thereof. The oxidizer composition and metal fuel are present in sufficient amounts, and are sufficiently intimately mixed to ensure a sufficient degree of contact in the composition between the oxidizer composition and the metal fuel, such that the autoignition composition has an autoignition temperature of no more than about 232°C. Therefore, although a wide variety of compositions fall within the scope of the present claims, the claims are not unduly broad and indefinite, and undue experimentation is not required to practice the presently claimed invention.

The specification clearly teaches how to make and use the presently claimed low temperature autoignition compositions. In particular, the specification provides various examples of compositions containing silver nitrate and a powdered metal fuel in amounts that will provide an autoignition material having an autoignition temperature of no more than 232°C, as recited in the claims. In addition, in light of the specification, the claims clearly define the invention, and are fully enabled by the specification, allowing one of ordinary skill in the art to practice the claimed invention. Following the teaching of the specification, one of ordinary skill in the art is able to obtain low temperature autoignition compositions that utilize the oxidizer compositions and metal fuels recited in the claims, but are not specifically taught in the examples. To practice the invention, one of ordinary skill in the art simply needs to select a silver nitrate based oxidizer composition having a crystalline phase transition, a melting point, a eutectic point, or peritectic point in the desired temperature range, and then write the balanced chemical equation for the reaction of the oxidizer composition and a specific metal fuel. Once the balanced equation is obtained, the stoichiometric amounts of each reactant follow directly from the equation, i.e., the balanced equation provides the mole ratio of oxidizer composition and metal fuel that is required to obtain a stoichiometric mixture. The amount of metal fuel can then be adjusted to obtain the desired autoignition temperature. Page 10, lines 8 to 25.

The specification also clearly teaches, at page 9, line 11, to page 11, line 36, that the driving force for the reaction of the oxidizer composition and the metal fuel follows from the electromotive series, i.e., the activity series, for metals. Metallic elements higher in the series will displace metallic elements lower in the series from a solution or melt of a salt of the lower metallic element by means of an oxidation-reduction reaction, i.e., the metallic element in the solution or melt is reduced to its elemental form by the other metal. For example, when copper metal is placed in a silver nitrate solution, the copper displaces the silver from the solution. As a result, particles of silver metal appear on the surface of the copper, and the solution turns blue as copper ions enter the solution. Therefore, one of ordinary skill in the art will clearly understand which metals will act as fuels with the presently claimed oxidizer compositions, and will be able to make and use low temperature autoignition compositions comprising those fuels and oxidizers without undue experimentation.

It will also be clear to one of ordinary skill in the art that the autoignition of the presently claimed autoignition compositions will not occur unless conditions are kinetically favorable for the reaction to occur. The required conditions will exist at or slightly lower than the temperature at which the oxidizer composition has at least one of a crystalline phase transition, a melting point, a eutectic point, or peritectic point. Therefore, the choice of oxidizer composition is, in part, controlled by the temperature at which at least one of a crystalline phase transition, melting point, eutectic point, or peritectic point of the oxidizer composition occurs, which may be easily obtained from reference texts, such as the Merck Index, or from simple calorimetry experiments, such as Differential Scanning Calorimetry. One of ordinary skill in the art will readily recognize that while the presently claimed silver nitrate may be used alone, other oxidizers recited in the claims must be utilized in combination with silver nitrate, as presently claimed, in a comelt or mixture to obtain the required crystalline phase transition, melting point, eutectic point, or peritectic point. For example, according to the Merck Index, silver nitrate melts at 212° C, and thus, comelting or mixing silver nitrate with a second oxidizer is not required to obtain a low temperature autoignition composition in accordance with the presently claimed invention. However, potassium perchlorate decomposes at 400°C, and, thus, must be mixed or comelted with at least silver nitrate as a second oxidizer to form a mixture or comelt that has a crystalline phase transition, melting point, eutectic point, or peritectic point of less than about 250°C to obtain the desired low temperature autoignition material. Examples of such mixtures or

comelts of oxidizers are provided in the specification. Thus, the specification clearly enables one of ordinary skill in the art to select the oxidizer compositions and metal fuels in the amounts required to obtain the low temperature autoignition compositions of the invention without undue experimentation.

With regard to the recitation of a solid organic amine that may be used in the oxidizer composition in combination with silver nitrate, Applicants submit that the claims do not recite that a solid organic amine is an oxidizer. Instead, the claims recite that the oxidizer composition comprises silver nitrate or a comelt or mixture comprising silver nitrate. The claims have been amended to recite that, in oxidizer compositions that comprise mixtures and comelts, at least one additional component selected from the group consisting of an alkali metal nitrate, an alkaline earth metal nitrate, a complex salt nitrate, a dried, hydrated nitrate, an alkali metal chlorate, an alkali metal perchlorate, an alkaline earth metal chlorate, an alkaline earth metal perchlorate, ammonium perchlorate, sodium nitrite, potassium nitrite, silver nitrite, a complex salt nitrite, a solid organic nitrate, a solid organic nitrite, or a solid organic amine is added to the composition with the fuel and oxidizer. The additional component may be, but is not necessarily, an oxidizer. Therefore, the claim does not recite that a solid organic amine is an oxidizer.

Therefore, the specification teaches the claimed invention in the full, clear, concise, and exact terms required to enable one of skill in the art to make and use the claimed invention, and the claims particularly point out and distinctly claim the subject matter that Applicants regard as the invention. Accordingly, the claims are fully enabled and are not indefinite, and it is respectfully requested that the Examiner withdraw the rejection of claims 1 and 13 to 18 under 35 U.S.C. § 112, first and second paragraphs, and the objection to the specification.

Claim 1 was rejected under 35 U.S.C. §102(b) as being fully met by Ellern for the reasons set forth on page 2 of the Office Action.

In response, Applicants submit that, as discussed above, the presently claimed invention, as recited in claim 1, is directed to a low temperature autoignition composition for safely initiating combustion of a main pyrotechnic charge in a gas generator or pyrotechnic device exposed to flame or a high temperature environment. The presently claimed low temperature autoignition compositions consist essentially of an intimate mixture of an oxidizer composition, which comprises silver nitrate, and a powdered metal fuel. The oxidizer composition comprises silver nitrate or a comelt or mixture comprising silver nitrate

and at least one additional component. Although most of the components recited in the claim are oxidizers, the at least one additional component need not be an oxidizer. The at least one additional component is selected from the group consisting of an alkali metal nitrate, an alkaline earth metal nitrate, a complex salt nitrate, a dried, hydrated nitrate, an alkali metal chlorate, an alkali metal perchlorate, an alkaline earth metal chlorate, an alkaline earth metal perchlorate, ammonium perchlorate, sodium nitrite, potassium nitrite, silver nitrite, a complex salt nitrite, a solid organic nitrate, a solid organic nitrite, and a solid organic amine. The metal fuel is selected from the group consisting of molybdenum, calcium, strontium, barium, titanium, zirconium, vanadium, niobium, tantalum, chromium, tungsten, manganese, iron, cobalt, nickel, copper, zinc, cadmium, tin, antimony, bismuth, aluminum, silicon, and mixtures thereof. The oxidizer composition has at least one of a crystalline phase transition, a melting point, a eutectic point, or peritectic point at a temperature of no more than about 250°C, and the metal fuel and oxidizer are present in amounts sufficient, and are sufficiently intimately mixed to ensure a sufficient degree of contact in the composition between the oxidizer and the metal fuel to provide an autoignition composition having an autoignition temperature of no more than about 232°C.

In contrast, Ellern discloses a mixture of magnesium powder and crushed silver nitrate that will burst into flame on contact with water. Page 46. However, magnesium is outside the scope of claim 1, and, therefore, Ellern does not disclose the presently claimed invention. As such, the presently claimed invention is not anticipated. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claim 1 under 35 U.S.C. §102(b).

Claims 1 and 13 to 18 were rejected under 35 U.S.C. § 103 as being allegedly-unpatentable over Sammons et al. ("Sammons") in view of Sidebottom, Garner '253, Healy, and Ellern et al. ("Ellern") for the reasons set forth on pages 2 and 3 of the Office Action.

In response, Applicants submit that Sammons discloses composite propellants, comprising an oxidizer and a metal fuel dispersed within a binder matrix. Column 1, lines 17 to 30 and 69 to 71, column 2, lines 1 to 4, column 5, lines 53 to 66, column 6, lines 13 to 44, and the examples. The binder is based upon a linear polymethylenenitramine that is polymerized after being mixed with the fuel and oxidizer. Column 2, line 1, to column 4, line 14, and the examples. Therefore, Sammons does not disclose or suggest a low temperature autoignition composition consisting essentially of an intimate mixture of an oxidizer composition comprising silver nitrate or a comelt or mixture comprising silver nitrate and at

least one of the other oxidizers recited in the claims and a powdered metal fuel, as recited in the claims. Instead, Sammons discloses a propellant in which the oxidizer and fuel are dispersed throughout a binder matrix. This lack of intimate mixing due to the presence of the binder materially affects the mixing of the oxidizer and the fuel in the compositions disclosed by Sammons, thus reducing the contact, i.e., preventing the required "intimate mixing require, between the oxidizer and the fuel required to obtain the presently claimed autoignition temperature range of from about 80° to about 232°C. Moreover, the only oxidizer disclosed by Sammons is ammonium perchlorate, which decomposes at about 380°C, a temperature that is significantly higher than the presently claimed 250°C. Therefore, Sammons does not teach or suggest the presently claimed invention.

The other cited references do nothing to overcome the deficiencies of Sammons. Sidebottom teaches gas generating compositions comprising an alkali or alkaline earth metal azide, an oxidizing compound, and an oxide of silicon, aluminum, titanium, tin, or zinc with or without silicon, aluminum, titanium, tin, or zinc metal. Column 1, lines 44 to 49. Examples include a composition containing sodium azide, silicon, and potassium perchlorate in molar proportions of 8:4:3 and a composition containing sodium azide, aluminum, and potassium chlorate in molar proportions of 2:2:1. column 3, lines 61 and 62, column 4, lines 45 and 46. Therefore, as with compositions comprising a binder, the azide separates the particles of oxidizer and metal, and affects the formation of an intimate mixture of an oxidizer composition and a powdered metal fuel. As a result, Sidebottom does not disclose or suggest the presently claimed intimate mixture of an oxidizer composition comprising silver nitrate or a comelt or mixture comprising silver nitrate and at least one of the other oxidizers recited in the claims and a metal fuel, whether taken alone or in combination with Sammons. Moreover, the only oxidizers disclosed by Sidebottom are potassium perchlorate and potassium chlorate, which have melting points of 400°C and 368°C, respectively. These melting points are significantly higher than those required in the presently claimed invention.

Garner '253 teaches the use of starch as a fuel/binder in pyrotechnic compositions, such as those used as gas generants in inflatable safety restraints. Therefore, Garner does not teach or suggest an intimate mixture of an oxidizer composition and a metal fuel. Instead, Garner teaches a pyrotechnic composition in which the oxidizer and fuel are separated by a binder.

Healy teaches a melt in fuel emulsion comprising a melt of ammonium nitrate in a fuel. Column 1, lines 9 and 10. The fuel is a water-insoluble non-self-explosive fuel selected from the group consisting of hydrocarbons, halogenated hydrocarbons, and mixtures thereof. Column 1, line 66, to column 2, line 9. Therefore, Healy also fails to teach or disclose the presently claimed intimate mixtures of oxidizers and metal fuels.

Ellern teaches that the melting point of silver nitrate is 214°C in Table 31, and that there is a relationship between the melting point or decomposition temperature of an oxidizer and its reaction temperature.

However, Ellern does not teach or suggest the presently claimed invention. Instead, in Tables 29 and 30, Ellern teaches various mixtures that have initiation temperatures that are much greater than the presently claimed 232°C. Moreover, Table 29 teaches that for mixtures of nitrate, perchlorate, and chlorate oxidizers with aluminum and magnesium, the initiation temperature is typically significantly higher than the melting point of the oxidizer.

Moreover, even if the teachings of Sammons were combined with the teachings of any of the other cited references, the combination would not provide the presently claimed intimate mixture of an oxidizer composition comprising silver nitrate or a comelt or mixture comprising silver nitrate and at least one of the other oxidizers recited in the claims and a powdered metal fuel. Instead, the combination would provide a propellant in which the oxidizer and fuel are dispersed throughout a binder matrix, thereby preventing the intimate mixing of the oxidizer and metal fuel. As a result, the cited references provide no motivation to one of ordinary skill in the art to obtain the presently claimed invention.

Therefore, Sammons, Sidebottom, Garner '253, Healy, and Ellern, whether taken alone or in combination do not teach or suggest the presently claimed invention, and fail to provide any motivation to one of ordinary skill in the art to obtain the presently claimed invention. Accordingly, the claims are not obvious, and it is respectfully requested that the Examiner withdraw the rejection of claims 1 and 13 to 18 under 35 U.S.C. § 103.

Claims 1 and 13 to 16 were rejected under 35 U.S.C. § 103 as being unpatentable over Halliday et al. ("Halliday") in view of Tepper and Ellern for the reasons set forth on page 3 of the Office Action.

In response, Applicants submit that Halliday teaches explosive "water-in-fuel" and "melt-in-fuel" emulsions, which comprise an oxidizer as the discontinuous phase, a fuel as the continuous phase, and a density reducing agent. Column 1, lines 17 to 33. The fuel should be substantially solid at ambient temperature, but should also have a softening point

above ambient temperature. Column 1, lines 41 to 49. Typical fuels include waxes, oils, liquid paraffin, xylene, toluene, petroleum, and dinitrotoluene. Column 1, lines 57 to 59, and column 3, lines 11 to 18. The softening point of the fuel should be above 35°, so that the fuel has a low viscosity at 85° to 95°C. Column 1, lines 59 to 62. Clearly the fuels disclosed by Halliday are not metals.

Although Halliday does teach that a solid fuel, such as atomized aluminum, may be blended together with the density reducing agent, column 1, lines 37 to 40, Halliday fails to teach or suggest the presently claimed intimate mixture of oxidizer composition and metal fuel. As Halliday teaches that the metal is dispersed throughout the continuous phase of the fuel with the density reducing agent, the metal is substantially separated from the oxidizer by the fuel, preventing intimate mixing of the metal fuel and oxidizer, as presently claimed.

Tepper does nothing to overcome the deficiencies of Halliday. Tepper teaches castable pyrotechnic compositions comprising powdered metal dispersed in a low-melting metal-nitrate or metal chlorate oxidizer. Column 1, lines 1 to 22. The powdered metal is dispersed in a melt of the oxidizer to form a slurry during the casting process, and, thus, the disclosed castable compositions must have high temperature stability, or they would autoignite during the casting process.

Tepper does not disclose an autoignition composition having an autoignition temperature of no more than about 232°C. The salt mixtures disclosed by Tepper melt below 250°, column 1, lines 56 and 57, and, as it must be assumed that the compositions do not autoignite during the casting process, the disclosed compositions do not have an autoignition temperature of no more than 232°C. Moreover, even if the teachings of Tepper and Halliday were combined, such that the metal fuels of Tepper were used in the emulsions of Halliday, the combination would not provide the presently claimed invention. Instead, one would obtain an explosive “water-in-fuel” or “melt-in-fuel” emulsion, comprising the discontinuous phase, a fuel as the continuous phase, a density reducing agent, and an optional metal fuel dispersed throughout the continuous phase of the fuel with the density reducing agent, so that the metal is substantially separated from the oxidizer by the fuel, preventing intimate mixing of the fuel and oxidizer, as presently claimed.

In Table 19, as stated in the Office Action, Ellern teaches the melting points and eutectics of various nitrates and mixtures of various nitrates. The melting points and eutectics of the nitrates and mixtures ranges from 52° to 561°C. However, Ellern does not

teach or suggest that the nitrates should be intimately mixed with a powdered metal fuel to form a low temperature autoignition composition having an autoignition temperature of no more than about 232°C.

Moreover, if the teaching of Ellern was combined with that of Halliday or Tepper, the combination would not provide the presently claimed invention. Instead, the combination would provide explosive "water-in-fuel" and "melt-in-fuel" emulsions in which the optional metal, if present, was dispersed through the fuel phase, making the intimate mixing of the metal fuel and oxidizer impossible.

Therefore, as Halliday, Tepper, and Ellern, whether taken alone or in combination do not teach or suggest the presently claimed intimate mixture of oxidizer and metal fuel, the present claims are not obvious. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 1 and 13 to 16 under 35 U.S.C. § 103.

Finally, new claims 27 to 29 are directed to low temperature autoignition composition for safely initiating combustion of a main pyrotechnic charge in a gas generator or pyrotechnic device exposed to flame or a high temperature environment, which comprises an intimate mixture of an oxidizer composition and a powdered metal fuel, where the oxidizer composition comprises a mixture or a comelt comprising silver nitrate and at least one additional component selected from the group consisting of an alkali metal nitrate, an alkaline earth metal nitrate, a complex salt nitrate, a dried, hydrated nitrate, silver nitrate, an alkali metal chlorate, an alkali metal perchlorate, an alkaline earth metal chlorate, an alkaline earth metal perchlorate, ammonium perchlorate, sodium nitrite, potassium nitrite, silver nitrite, a complex salt nitrite, a solid organic nitrate, a solid organic nitrite, and a solid organic amine, wherein the metal fuel and oxidizer are sufficiently intimately mixed to ensure a sufficient degree of contact in the composition between the oxidizer and the metal fuel to provide an autoignition composition having an autoignition temperature of no more than about 232°C. As none of the cited references, whether taken alone or in combination, teach, disclose, or even suggest an intimate mixture of an oxidizer composition and a powdered metal fuel, where the oxidizer composition comprises a mixture or a comelt comprising silver nitrate and the at least one additional component recited in the claims, the new claims are not anticipated or obvious over the cited prior art. Moreover, as discussed above, one of ordinary skill in the art would be able to make and use the presently claimed invention without undue experimentation.

Applicants thus submit that the entire application is now in condition for allowance, early notice of which would be appreciated. Should the Examiner not agree with the Applicants' position, then a personal or telephonic interview is respectfully requested to discuss any remaining issues and expedite the eventual allowance of the application.

No fee is believed to be due for the filing of this amendment. A separate Fee Sheet for the new claims and a separate petition for extension of time are filed concurrently herewith. Should any additional fees be found to be due, however, please charge the required amount to Pennie & Edmonds LLP Deposit Account No. 16-1150.

Respectfully submitted,

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Enclosures